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PHYSICAL CHARACTERISTICS OF FLORIDA ORANGE OIL PRODUCED DURING 1937-38 SEASON*

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During recent years the manufacture of orange oil, as well as grapefruit oil, has increased to a notable extent in Florida. There has been difficulty in some instances in disposing of the orange oil because certain batches would not meet the U.S.P. standards, and because there appeared to be a lack of uniformity between different batches. This is probably due in part to the fact that in Florida production of oil is not under laboratory control and no attempt is made to examine each batch with the thought of subsequent blending to obtain a product of uniform quality.

The purpose of the present paper is to review the methods now being used in Florida to produce orange oil, and to present data relative to the physical constants of the oil manufactured by different producers during the 1937-38 season.

The oils examined were composite samples, made up of samples from each week's run during the season, and represent the production from several thousand tons of fruit. After collection, the samples were placed in well-filled glass containers and stored in the ice box until ready for examination. Analyses were made according to the usual procedures.[1]

COMMERCIAL METHODS OF PREPARATION

In California, oil is prepared by crushing the whole fruit with subsequent centrifuging and separating of solids, juice and oil; or by grinding the peel and washing out the oil with water. Other methods are used but are considered trade secrets. In Florida, only the peel of the fruit is used; this consists of the waste from canning plants and raspings of the fruit obtained prior to canning. Oil is prepared from the waste by:

1. Passing the peel between ribbed drums (Pipkin process).
2. Grinding and pressing the peel in a screw press.
3. Rasping the whole fruit.

Extraction of Oil by Passing the Peel Between Ribbed Drums (Pipkin Process).

The machine used in this process, which is described in U.S. Patent 2,004,056, consists of two stainless steel drums between which the peel is passed. The drums or rolls are adjustable to control the pressure on the peel, and the pressure maintained is merely sufficient to puncture the oil cells without actually crushing the peel. The rolls are grooved, the grooves running around the circumference of the rolls and being deep enough to receive the oil from the punctured cells and retain it out of contact with the peel as the rolls revolve. However, some of the oil is retained by the peel, and the albedo of the fruit may act as a sort of sponge, soaking-up some of the oil from the grooves.

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* Food Research Division Publication No. 414
Published in The Fruit Products Journal, April 1939 issue, Vol. 18, No. 8
pp. 228-30; 249, 251.

The bulk of oil produced in Florida is made by means of this machine. The machines are not sold, but are placed by the patentee in different canneries throughout the State through agreements whereby the canners furnish power and raw material and the patentee buys the oil at a fixed price per pound.

The Pipkin machine is somewhat similar to the Cianciolo machine which was patented in 1927 by Luigi and Ettore Cianciolo but is not used today[2]. However, the Cianciolo machine uses sprays of water, while the Pipkin machine does not. In the Cianciolo machine the peels are fed in singly by hand whereas in the Pipkin machine the peel is fed automatically. Operation of the Cianciolo machine requires five boys, the Pipkin machine requires the attention of only one man.

The yield of orange oil from the Pipkin machine is said to amount to about six pounds per ton of fruit.

Extraction of Oil by Grinding and Pressing the Peel. This method is slower than the Pipkin process because of the limited capacities of the types of presses now being used. These presses are of the tapered screw design commonly found on the market for pulping berries and vegetables. Water may or may not be used in conjunction with grinding. Manufacturers of oil using this type of press are not usually quantity producers, but the manufacture of oil is merely a side-line in the canning of orange juice.

Yield by this method is very low, and is said to amount to from 12 to 20 ounces per ton of fruit. The low yield is probably due to retention of oil by the peel as it leaves the press.

Extraction of Oil by Rasping the Fruit. In 1938, only one producer was using this method, the technique of which is somewhat similar to that of the Avena machine used in Sicily. The fruit is made to travel with considerable speed along the length of a spiral corridor having stainless steel walls roughened in a grater-like fashion. The fruit rolling over and over as it is propelled along the corridor, scrapes against the roughened walls, thus rasping their flavedo from the fruit. Sprays of water play on the fruit to wash away the oil and grated peel which are subsequently screened, the emulsion of oil and water flowing to settling tanks. The machine is not enclosed and there is undoubtedly considerable loss of oil, as evidenced by the lachrymal effect of the air in the immediate vicinity of the rasper.

Oil produced by this method is generally amber in color. It is claimed that the yield of oil amounts to from two to four pounds per ton of fruit.

All of the methods described above give an emulsion of oil and water which is screened and then centrifuged. In the first two methods described, this emulsion is centrifuged immediately, but where the fruit is rasped the emulsion is generally allowed to stand to facilitate settling.

In another method, of limited use, the oil is prepared as a by-product in the preservation of orange juice by the Ayers-Lang method[3] whereby the juice from rasped, pressed fruit is concentrated to about 90 per cent of its original volume before processing. The oil is obtained during this concentration and should be called a distilled oil, rather than a cold pressed oil. The product may be colorless, but more often it is light yellow.

The characteristics of Florida orange oil produced by the methods discussed above are given in Table 1. From this table it may be seen that there is little difference in properties between the oil made by the Pipkin machine and that produced by the screw press method. The oil prepared by rasping and that obtained in the Ayers-Lang method for preserving juices differ considerably in characteristics from those obtained by the first two methods described above. Of special interest are the high solid content and low optical rotation of the oil obtained by rasping. The high solid content may be due to the comparatively large quantities of water used during the process, which dissolve appreciable amounts of peel solids. Worthy of note, too, is the high solid content of the oil obtained in the Ayers-Lang process. The total solids of this oil are higher than normally found in a distilled oil.

Characteristics of Orange Oil from Different Varieties of Florida Oranges. The bulk of the orange oil produced in Florida is obtained from Valencias. Oil is, however, made from early varieties such as Pineapples, Seedlings* and Satsumas. At the present time, no attempt is made to keep separate the oil made from these different varieties. Table II shows the characteristics of oils commercially produced in Florida during 1937-38 from different varieties of oranges. Data are not given in this table for oil obtained by rasping the fruit nor for oil produced during the Ayers-Lang Process for juice preservation.

There is no great difference in characteristics between the oils obtained from the different varieties observed. Differences are no greater than those between different lots of the same variety. It would perhaps be expected that the characteristics of Satsuma oil would be similar to those of tangerine oil, since both varieties belong to the same botanical species and horticultural race. If Nelson's data for tangerine oil[4] are compared with those in Table II for Satsuma oil, it will be seen that there is no similarity in characteristics.

Correlation of Physical Properties of the Oil with Time of Production. A study of the analyses of the different oils produced during the season fails to reveal any correlation between their physical properties and time of production; nor is there a definite trend in their properties during the season. A scatter diagram indicating the total solids content during the season's production is shown in Fig. 3. From this diagram it will be seen that there is no correlation between total solids and time of production. Oil obtained by rasping and that produced during the Ayers-Lang Process are not represented in these data.

Table III shows that there are no marked differences in physical properties of the oils produced from fruit of five different Florida counties, with the possible exception that oil produced from Hardee County fruit has a higher total solid content than that of oils from fruit grown in the other counties represented by the investigation. The apparent difference, however, may be due to the small number of samples examined.

SUMMARY AND CONCLUSION

Methods for the commercial production of orange oil as now practiced in Florida are outlined.

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*There is a difference of opinion as to whether or not seedlings are actually a distinct variety.

There is no difference in physical characteristics of the oils prepared commercially from different varieties of Florida fruit.

There is no correlation between time of commercial production and physical characteristics of the oil.

Oils produced from fruit grown in five different counties show no differences in physical characteristics, with the possible exception that oil from fruit grown in Hardee County may have a higher total solid content.

The method of preparation has an effect upon the physical characteristics of the oil.

1. Methods of Analysis Assoc. Official Agri. Chemists.
2. Donovan, "Perfumery and Essential Oil Record", Annual Special No. p. 3, 1937.
3. U. S. Pat. 2,054,066, 1936.
4. Nelson, "Am. Perfumer and Essential Oil Review", Sept. 1934.

Table I - Characteristics of Orange Oil Obtained by Different Methods of Extraction (Valencia Variety Only) 1937-38

Method	No. of Samples Analyzed	Sp.Gr. 25°/25°	Refractive Index at 20°	Total Solids %	Optical Rotation at 25°	10% Distillate Opt. Rot. at 25°	10% Distillate Ref. Ind. at 20°
Pipkin Machine	10	0.8435	1.4726	3.99	96.38	97.53	1.4720
Screw Press	10	0.8434	1.4723	3.76	97.20	97.72	1.4722
Rasping	6	0.8471	1.4742	10.27	93.62	98.31	1.4725
From Ayers-Lang Process	2	0.8415	1.4731	6.91	97.85	.....	......

Table II - Characteristics of Florida Orange Oil Produced from Different Varieties of Fruit. 1937-38*

Variety	No. of Samples Analyzed	Sp.Gr. 25°/25°	Refractive Index at 20°	Total Solids %	Optical Rotation at 25°	10% Distillate Opt. Rot. at 25°	10% Distillate Ref. Index at 20°
Valencia	20	0.8435	1.4725	3.87	96.79	97.63	1.4721
Pineapples	4	0.8437	1.4726	3.82	96.12	97.40	1.4717
Satsumas	2	0.8436	1.4728	3.65	96.88	97.65	1.4721
Navels	2	0.8436	1.4729	3.77	96.33	97.72	1.4720
Temples & P.apples	1	0.8433	1.4725	4.43	95.70	97.37	1.4721
P.apples & Seedlings	2	0.8434	1.4724	4.33	97.02	97.64	1.4718
Temples & Valencias	1	0.8437	1.4728	5.21	96.81	97.09	1.4720
P.apples & Valencias	2	0.8435	1.4723	3.95	96.33	97.92	1.4718
Average		0.8434	1.4726	4.18	96.49	97.55	1.4719
Maximum		0.8454	1.4730	5.21	97.51	98.20	1.4728
Minimum		0.8427	1.4720	2.71	95.26	96.67	1.4700

*Does not include oil by rasping or that produced during Ayers-Lang Process

Table III - Characteristics of Florida Orange Oil as Produced in Different Counties 1937-38*

County	No. of Samples Analyzed	Sp.Gr. 25°/25°	Refractive Index at 20°	Total Solids %	Optical Rotation at 25°	10% Distillate Opt. Rot. at 25°	10% Distillate Ref. Index at 20°
Orange	12	0.8435	1.4726	3.68	96.99	96.67	1.4722
Polk	10	0.8433	1.4726	4.08	96.23	97.34	1.4720
Highlands ..	4	0.8438	1.4726	3.86	96.36	97.55	1.4720
Indian River	2	0.8438	1.4726	4.57	96.74	97.51	1.4720
Hardee	2	0.8441	1.4729	4.97	96.26	97.78	1.4715

*Does not include data of oil from rasping or oil obtained in the Ayers-Lang process

Table IV - Average Analyses of California and Florida Orange Oils, and U.S.P. (XI) Specifications

	Sp.Gr. 25°/25°	Ref.Index at 20°	Tot. Sol. %	Opt.Rot. at 25°	10% Distillate Opt.Rot. at 25°	10% Distillate Ref. Ind. at 20°
Cal. Valencias*	0.8440	1.4735	3.61	97.78	99.21	1.4723
Cal. Navel*	0.8445	1.4738	4.53	96.93	98.71	1.4724
Fla. (all varieties)**	0.8434	1.4726	4.18	96.49	97.55	1.4719
U.S.P. XI Specifications	0.842 to 0.846	1.4723 to 1.4737	not less than 2.0%	not less than +94° and not more than +99° in 100 mm tube	equal to original oil, or not more than +2° difference	not less than 0.0008 & not more than 0.0015 lower than original oil

* Poore, U.S. Dept. Agri. Techn. Bull. 241 (1932).
** 1937-38 Season

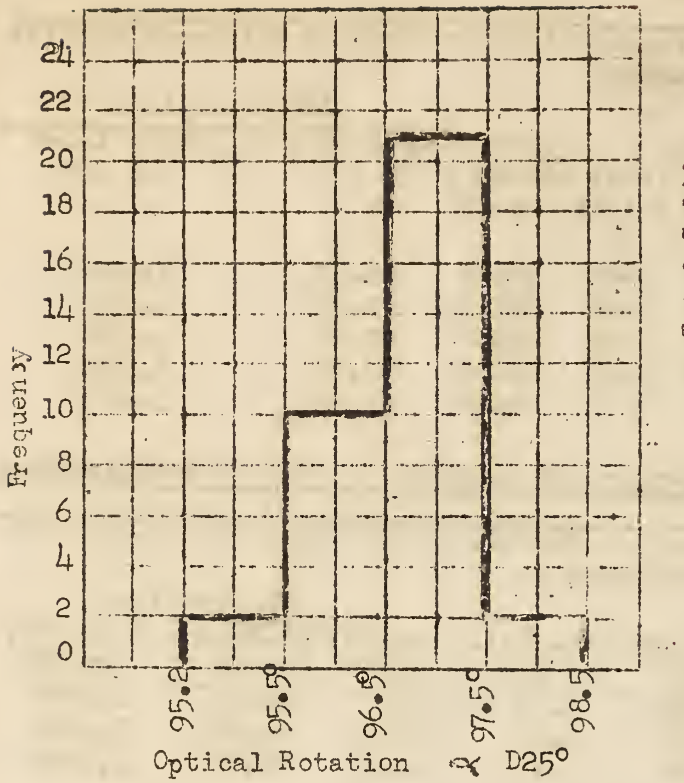

Figure 2
Histogram showing frequency distribution of Variation in Optical Rotation of Florida Orange Oil (1937-1938 season).

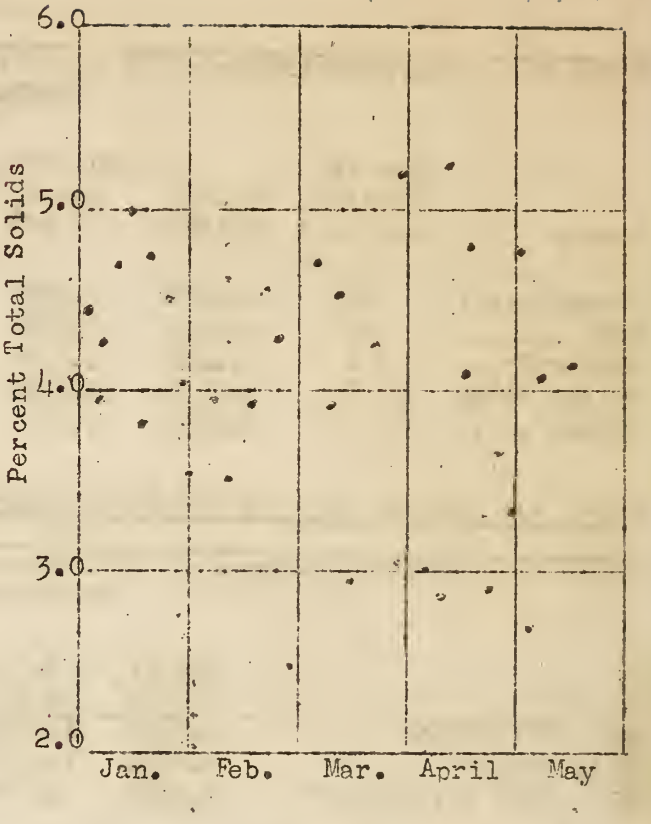

Figure 3
Scatter diagram indicating no correlation between total solids in Florida orange oil and time of production (1937-38 season).

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